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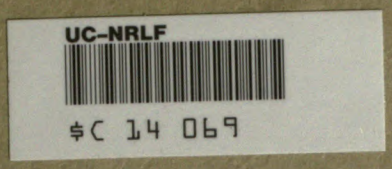

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IN

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MEMORANDUM ON THE CULTURE OF WILD SILKWORMS IN SOUTH-EASTERN MANCHURIA.

The wild silkworm of South-eastern Manchuria, commonly called by the Chinese *shan tsan* (山蠶), and classified by Hosie as the "*Antherea Pernyi*, otherwise known as *Bombyx Pernyi* and *Bombyx Fantoni*," produces much of the silk used in the manufacture of pongees throughout China and Japan. To the farmers of this region the industry has become a most profitable supplement to their agricultural work, for practically all of these landowners whose boundaries include hilly ground make silk raising a part of the regular routine of their households. Although in many places the hills have not the necessary scrub-oaks on the leaves of which the worms feed, it has been demonstrated that these can be readily planted and nurtured, so that, with nearly perfect climatic conditions, there seems every likelihood of the industry expanding indefinitely to meet the increasing demand in many countries for both the wild silk and the pongees. This probability is also increased by the announcement of two recent inventions in Tokio, which should bring tussah upon the market as a competitor with the domestic raw silks of China and Japan: the first is a new process for bleaching the silk, which will render it amenable to dyeing; while the second is a spinning machine, which makes a smoother and more uniform thread than is now procurable.

Soil.

Throughout this region the hills and mountains, which crowd group upon group, broken at frequent intervals by rich valleys and sandy streams, are largely composed of granite and shale, hard or in the various stages of disintegration. The oaks grow at all elevations, from the rich slopes of the hills near the bottom land to the line of the barren steep rocks above, and are found at their best on the sunny faces of the lower mounds, where the soil is often that rich black loam one finds in the depths of a virgin forest.

Trees.

Two or three distinct varieties of trees are found in most neighbourhoods to furnish feeding-grounds for the silkworms, although the Chinese generally refer to them all as simply oaks (柞木). Hosie also dismisses the subject with the observation that the worm "feeds and spins on the oak called *Quercus mongolica*." Closer inquiry shows, however, that the Chinese

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classify three separate species as *hu-po-lo* (胡波羅), *chien-tso* (尖柞), and *ch'ing-t'ang* (青塘) or *ch'ing-kang* (青杠). The first and most common of these has a broad leaf and a thick, black bark. Of the other two less familiar ones, the *chien-tso* carries a narrow leaf and a thinner, more greyish, bark; while the *ch'ing-kang* has a green bark and a leaf slightly larger than that of the *chien-tso*, with a more ragged edge.

When allowed to develop on the lower slopes, these oaks attain to a height of 20 or 30 feet, so far as I have been able to observe. Along the higher contours they seem to remain dwarfish. Also when used for grazing they are frequently cut well back, to secure a more tender—and a more accessible, I should say—leaf.

Culture of the Worms.

Of the accuracy of the principal facts given in this section, I am reasonably certain, as the information has been secured and checked by inquiries in many different places; yet on one feature of the silkworm's life as here sketched I have had difficulty in determining which of its historians is correct, so diverse have been their many accounts. This feature is the number of days spent in the larva stage of development, that is, the period between the birth of the worm from the egg and the spinning of the cocoon, which marks the transition to the pupa stage. To clear this point I have spent several hours talking with the producers in their own cottages, and have elected to give below the account of an intelligent farmer's son, who himself cares for the worms during their development on the trees.

It will be easiest to trace the worm's life by beginning with the appearance of the summer butterfly. This year the first of the imagoes pierced their cocoons about the 20th and 21st July, while the later ones followed throughout a period of 10 or 11 days, which is the average time intervening between the earliest and the latest *débuts*. Most of the butterflies come out late in the afternoon, that is, just before or at the sunset hour. About 9 in the evening the attendants place the males and females together and leave them until, approximately, 3 P.M. of the following day, or 18 hours. As the male worm serves but one female, when he is taken away from the female on the afternoon of the 2nd day, he is cast aside to die within from 24 to 36 hours. The female is at once carried out to the trees, where she is tied down to a twig with a species of grass known among the producers as "silkworm grass" (蠶草) or "three-cornered grass" (三稜草). She then lays on a leaf or branch somewhere between 100 and 200 eggs—this number seemed to be very approximate—during the evening and night of this 2nd day, has her bonds loosed by the watcher the following morning, to be put into a basket and kept for eating or to fly away to enjoy the two or three sunsets that are given her to see.

If the weather is favourable, the eggs hatch in from 11 to 12 days—say, roughly, on the 14th day. The larva, born black, begins eating almost at once and continues throughout three days to the period of the first of the four "sleeps"—*ts'an mien* (蠶 眠),—which, although it lasts only two or two and a half days, affords opportunity for the first molt—*t'o p'i* (脫 皮),—from black to green. This sleep ends, approximately, on the 19th day. Following it comes a second eating period, this time of four days duration, preparatory for the second sleep and shedding that occupies three days and brings the total to 26. A repetition of this four days feast and three days rest, with another molt during the latter, marks the end of the third sleep at the 33rd day, after which there comes an exactly similar cycle that ends with the completion of the fourth molt on the 40th day. In each of these four changes the worm sheds its skin completely, including the hard surface of the face and head, and through them keeps pace with the increase in size which ultimately brings it to a length of from 3 to 5 inches. The exuviæ appear on the leaves and in the crotches of the limbs as small brown balls about one-eighth of an inch in diameter.

It is this period, from the birth of the worm to the end of the last sleep on the 40th day, which proved most difficult to verify satisfactorily. CHANG, the watcher of his father's hillside flock, insisted that it usually occupied 27 days, so that I have elected to abide by his information and put the completion of the final rest in the 41st day.

Then follows the last period of nourishment, covering, as a rule, 13 or 14 days, which precedes the spinning of the cocoon and during which the larva attains to its most beautiful stage of development. After the 55th day, when feeding ceases, the task of spinning the cocoon, entered upon at once, occupies, on an average, five days, thus bringing the total to a round 60. Some cocoons are perfected in as few as three days while others require eight, depending largely upon the conditions of the weather: dark, rainy days tend to deaden the larva's activity.

When ready to spin, the worms display much cleverness in choosing places protected both from the rain and from the eye of the passer-by. Whether this latter be one of Nature's gifts of intuition to the industrious spinner may be hazarded only a guess, but it may be unhesitatingly stated that this placing of the cocoons renders very thorough search necessary to ensure a full harvest. When thus completed, the cocoons are gathered by the watchers each day as they return to their cottages and are there stored in open trays to await the cooler days when they may be safely packed.

These watchers who guard the worms and care for them have two important duties. First, they must see that the birds are kept away from their oaks, for otherwise their colony of spinners will be sadly thinned. This guard duty involves with them much shouting and

much cracking of the long whips they carry for this purpose, as well as keeping their red flags all aflying. Secondly, they must see that the worms have enough leaves to eat, moving them whenever one tree is trimmed to another untouched oak. Frequently the whole crop is gradually carried in baskets from a hillside shorn of its foliage to a neighbouring one just waiting to be cropped. In this work of watching and tending the worms during their larva state one man is counted on as being able to care for about 4,000 during the spring culture and, roughly, 5,000 in the autumn.

Taking the 20th July as the date when the first imagoes appeared and the 31st July as, approximately, the time when the last ones pierced their shells, we see that, with from 60 to 65 days—allowing for sluggards—allotted to the larva stage, the whole crop should have matured this year during the first week or 10 days of October. It is not, however, safe to fix definite limits for this culture period, as it may be, and is, much influenced by the time when the spring eggs are set for incubation. However, it is known that the first baskets came down for shipment this year during the latter part of October, and that the stream continued right up to December, with a high-water mark between the 10th and 15th November.

The ordinary producer does not retain any portion of his autumn crop to provide ancestors for his spring family, dismissing the subject with the observation that his cocoons are not desirable ones for breeding. To secure those which are most promising for this purpose, he uses one of two methods: either he procures some seed cocoons from a special district which is noted for its superior product, or he inquires among the producers of his own neighbourhood to ascertain which "home" has had an especially good crop and has consequently saved over a portion of it to sell as seed for the coming season. These he buys in the spring at prices ranging from 50 to 100 per cent. higher than the ordinary values of the mercantile cocoons of the autumn. These seed cocoons must be kept in a room tempered by artificial heat—usually only that of the *k'ang*,—to render certain their escape from the killing Manchurian frosts, although they will, according to CHANG, live through the exposure of an open life if the snows come in time to cover and protect them. Yet, in spite of this generally accepted belief in the power of the frosts to kill the chrysalides, a Japanese firm has erected and equipped a plant for baking the cocoons they secure during the winter to make sure of landing them unpunctured in Japan when navigation opens in the spring. The precautionary measures of the Chinese to attain this result consists in exposing the cocoons to the cold and wind at intervals of every 20 days throughout the winter months; they do not use the baking process at all.

When the seed cocoons have been properly cared for, the butterflies appear at about the *Ch'ing Ming* (清 明), which usually falls in the early part of April in the Western calendar.

They follow the same course as the autumn cocoons up to the time when the male and female are separated, when, instead of being tied to trees, the females are placed in baskets provided with dried grass or twigs on which they may lay their eggs. These then must be set aside in a cool place for a fortnight before the process of incubation is allowed to begin, otherwise the worms will hatch before the leaves are sufficiently advanced to provide their food. Again, as in the autumn, about 11 days are necessary to effect the metamorphosis to the larva stage; but here a change of process again necessarily occurs. As the worms appear in the baskets, the edges are lined with leaves, on which they begin feeding and on which they are carried to the trees. From this time on their development follows closely the ancestral lines of the autumn, save that the larva state is apt to occupy a few days more.

Assuming that the *Ch'ing Ming* falls early in April, the fortnight's inhibition added to the period of incubation brings the date of the larva's appearance to early in May, after which the 45 to 47 days of feeding and spinning will consume the month of May and, say, 25 days of June. Adding then the pupa's rest of a fortnight within the cocoon, we come down to the 10th to 15th July as the average date of the appearance of the autumn imago, whose life story has already been sketched.

Silk-producing Qualities.

Turning to the silk-producing qualities of these cocoons, I find that conservative estimates place the amount that can be reeled from 1,000 spring cocoons at from 4 to 6 *liang* (兩), that is, from 5⅓ to 8 ounces avoirdupois, and the amount from 1,000 of the heavier autumn cocoons at from 6 to 9 *liang*, the equivalent of from 8 to 12 ounces avoirdupois. From the pierced cocoons about 4 *liang* is expected.

Prices of Silk and Cocoons.

The cocoons of different years yield different average amounts of silk, so that their market value depends upon two factors: (1) the price of silk and (2) the silk-producing qualities of the season's crop.

Seven or eight years ago the average price of a picul of wild raw silk was, according to Hosie, *Hk.Tls.* 150 (say, 25 pounds sterling), while the extreme quotations within a few years of that time touched *Hk.Tls.* 80 and *Hk.Tls.* 200. This season the highest figure ever known to local merchants was reached when silk sold for *Antung Tls.* 0.14 a *liang*, which works out at *Hk.Tls.* 206 per picul; whereas the average price has of late years been *Antung Tls.* 0.10 or *Antung Tls.* 0.11 per *liang*, meaning *Hk.Tls.* 148 and *Hk.Tls.* 162 per picul respectively.

From the value of the silk the price of the cocoons is usually computed by taking the selling price of the silk procurable from 1,000 cocoons as the purchasing price of the cocoons themselves. With the cost of the raw material thus just covered by the returns from the silk spun, the filature owner looks to the by-product of waste silk—approximately equal in weight to the pure silk—to pay for the labour in spinning and to provide the profit. Although great fluctuations in the price of these cocoons have taken place this year, it may be safely stated that the average has been from *Antung Tls.* 1.10 to *Antung Tls.* 1.20 per 1,000, equal—taking, say, 2*s.* 9*d.* to the Shanghai tael—to from 3*s.* 2*d.* to 3*s.* 6*d.* Just within the past month, however, the price on the Chefoo market, which regulates sales here, broke so violently under the weight of the heavy shipments from these eastern ports that 1,000 cocoons could be bought there, with duty, freight, and all incidentals paid, at such low figures as from *Tls.* 0.90 to *Tls.* 1. The pierced cocoons command, generally, a little over one-third the value of the others.

Weight of Cocoons.

It may be useful also to append here a note on the weight of the autumn cocoons as we have been able to observe it in different stages of the cocoon's age. When just fresh from the trees—that is, those brought down for shipment in October,—1,000 average very close to 10 catties (斤), or 13⅓ pounds avoirdupois; while these same cocoons in spring, after the chrysalides have been killed and dried by the exposure of the winter, do not, as a general rule, exceed from 6½ to 8 catties. The pierced cocoons tipped at from 1½ to 2 catties.

Marketing the Cocoons.

To prepare these cocoons for shipment, the countryman puts about 30,000 into a basket woven of willow twigs—which he buys from the weaver at from $1 to $2—and shaped much like a hogshead. Although these vary in capacity and weight, the average was found to be about 30,000 cocoons, weighing 3 piculs, or 400 pounds avoirdupois, net in the autumn, and 35,000, weighing 2½ piculs, or 330 pounds, in the spring.

Usually two or three such baskets are placed on the Manchurian cart, to be hauled down over the still muddy autumn roads by from four to seven cart animals, which means an incongruous mixture of ponies, mules, donkeys, oxen, and cows. And a stirring sight it is up on the pass that leads the Fêng-huang-ch'êng road into Antung during one of those feverish days when the cargo is being rushed down for shipment before the ice forms in the river, as the gully-like roadbeds on either side of the divide absolutely teem with struggling animals and shouting carters trying to get their loads over the almost heartbreaking obstacles which go to make up a Manchurian road. Once in the town the baskets are taken to the grounds or sheds of the

commission hongs, where they are dumped and repacked, thus offering the buyers from Chefoo an opportunity to make their selections and bargain with the owners as to price.

This Season's Crop.

During this year the total number of such baskets leaving this port has been about 26,000, with a total net weight of cocoons of over 80,000 piculs, or 10,666,667 pounds avoirdupois. Of these, more than 23,000 baskets were destined for Chefoo; the remainder for Japan. The season's crop has been an unusually large one, owing chiefly to an allowance for losses which did not occur. Last year the bees, inveterate enemies of the young larvæ, killed, it is estimated, one-half the worms placed on the trees; so this year, to provide for this heavy toll upon their output, the producers started double the number of worms that they expected to mature into cocoons. Then, as the bees did not return to their former hunting-grounds, the farmers found that by some extra labour in guarding and providing food for their more numerous wards they were able to count an unexpectedly numerous family of grown-ups when the evening of the year rolled round.

LEWIS S. PALEN,
Acting Commissioner of Customs.

CUSTOM HOUSE,
ANTUNG, MANCHURIA, *7th December* 1907.

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